

AMENDMENTS TO THE DRAWINGS

Enclosed with this Amendment is a Replacement Sheet for Sheet 4 of the drawings. In the Replacement Sheet, reference numeral 212 is removed from original Fig. 8.

REMARKS

This Amendment is being filed responsive to the November 16, 2004 Office action that was issued in connection with the above-identified patent application. Prior to the entry of the above amendments, claims 1-43 were pending and stand rejected. By the above amendments, the specification, drawings, and claims 1, 6, 7, 27, and 36 are amended, claims 44-68 are added, and claims 4-5, 11-12, 14-15, 17-18, 21-26, 30, 32, and 37-43 are cancelled without prejudice.

In the Office action, the drawings were objected to for not containing reference numeral 212. Upon review of the original specification and drawings, Applicants submit that the discrepancy is actually that Fig. 8 contains reference numeral 212 but the specification does not refer to this reference numeral. Accordingly, Applicants propose amending Fig. 8 to remove reference numeral 212. A replacement sheet for original sheet 4 of the drawings is enclosed with this Amendment. In the replacement sheet, Fig. 8 has been amended to remove reference numeral 212. Applicants are appreciative of the Examiner's attention to detail in recognizing this inconsistency between the drawings and the written specification.

In Applicants' review of the original specification, it was also noticed that pages 19 and 20 of the specification refers to the previously discussed source 22 as being illustrated in Fig. 7. Reference numeral 22 is not shown in Fig. 7. Accordingly, Applicants have amended the last paragraph on page 19 of the specification to remove the use of reference numeral 22.

In the Office action, claims 27, 33-35, and 37 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,106,963 to Nitta, et al.

(“Nitta”). Claims 1, 2, 5, 7-12, 20, and 28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of U.S. Patent No. 6,045,933 to Okamoto (“Okamoto”). Claims 3, 4, and 6 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of Okamoto and ordinary skill in the art. Claims 13-17, and 21-26 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of Okamoto and further in view of *Fuel Cell Systems*. Claim 18 was rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of Okamoto and further in view of U.S. Patent Application Publication No. 2003/0031908 to Bostaph et al. (“Bostaph”). Claim 19 was rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of Okamoto and further in view of U.S. Patent Application Publication No. 2001/0026884 to Appleby et al. (“Appleby”). Claims 29-32, 36, and 38-43 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nitta in view of *Fuel Cell Systems*.

Applicants have studied the cited references in view of the pending claims and the reasons expressed in the Office action. Applicants respectfully disagree that the subject matter of all the original claims was anticipated or rendered obvious by the cited references. However, Applicants have amended the claims as noted above, and discussed below, to recite subject matter that is neither disclosed nor suggested in the cited references, individually or in any permitted combination thereof. Applicants request reconsideration of the rejections for at least the reasons discussed below. For ease of examination, the following discussion is presented on an independent claim by independent claim basis, with the amended claims being reproduced below. Illustrative ones of the dependent claims that depend from each independent claim are then discussed

before proceeding to the next independent claim. Applicants are hopeful that this format will reduce the Examiner's time considering this response.

Amended claim 1 is reproduced below and recites a fuel cell system that includes an oxygen-enrichment assembly that utilizes at least one oxygen-selective membrane to produce an oxygen-enriched air stream for the cathode region of a fuel cell stack, as well as a water recovery assembly that is adapted to recover water from the cathode exhaust stream from the fuel cell stack.

1. A fuel cell system, comprising:

a fuel processing assembly adapted to produce a product hydrogen stream containing at least substantially pure hydrogen gas from at least one feed stream that comprises at least a carbon-containing feedstock;

an air delivery system adapted to receive an air stream having a concentration of oxygen gas and to produce therefrom an oxygen-enriched stream having a greater concentration of oxygen gas than the air stream, wherein the air delivery system includes at least one oxygen-enrichment assembly adapted to produce the oxygen-enriched stream from the air stream, and further wherein the oxygen-enrichment assembly includes at least one oxygen-selective membrane;

a fuel cell stack adapted to receive at least a portion of the product hydrogen stream and the oxygen-enriched stream and to produce an electric current therefrom; wherein the fuel cell stack is adapted to emit a cathode exhaust stream containing water; and

a water-recovery assembly adapted to receive the cathode exhaust stream and to produce a product water stream therefrom.

Amended independent claim 1 recites, amongst other subject matter, a fuel cell system with a fuel processing assembly that is adapted to produce a product hydrogen stream, an air delivery system that includes at last one oxygen-selective membrane and which receives an air stream and produces an oxygen-enriched stream therefrom, and a fuel cell stack that is adapted to receive at least a portion of the product hydrogen stream and the oxygen-enriched stream to produce an electric current therefrom. Amended

claim 1 further recites that the system includes a water recovery assembly that is adapted to produce a product water stream from the cathode exhaust stream of the fuel cell stack.

Applicants agree with the Examiner that Nitta discloses a system that includes a fuel processing assembly, an oxygen-enrichment system, and a fuel cell system that is adapted to receive the product hydrogen stream and the oxygen-enriched stream. Nitta also discloses a cathode exhaust stream and provides an example of a water recovery system. However, Nitta does not disclose or suggest a fuel cell system with the membrane-based oxygen-enrichment assembly recited in amended claim 1. To the contrary, Nitta requires that the oxygen-enrichment assembly utilize a magnetic separation device to produce the oxygen-enriched stream. The disclosure of Nitta is discussed below to point out this distinction, including the fact that Nitta specifically teaches away from the subject matter recited in amended claim 1.

Nitta discloses several configurations for fuel cell systems that are specially designed for use in electric vehicles. As discussed in the background of Nitta, in such vehicular applications, space is at a premium and durability and energy requirements are critical constraints. An exemplary embodiment, shown in Nitta Figure 10, is reproduced below for the Examiner's convenience.

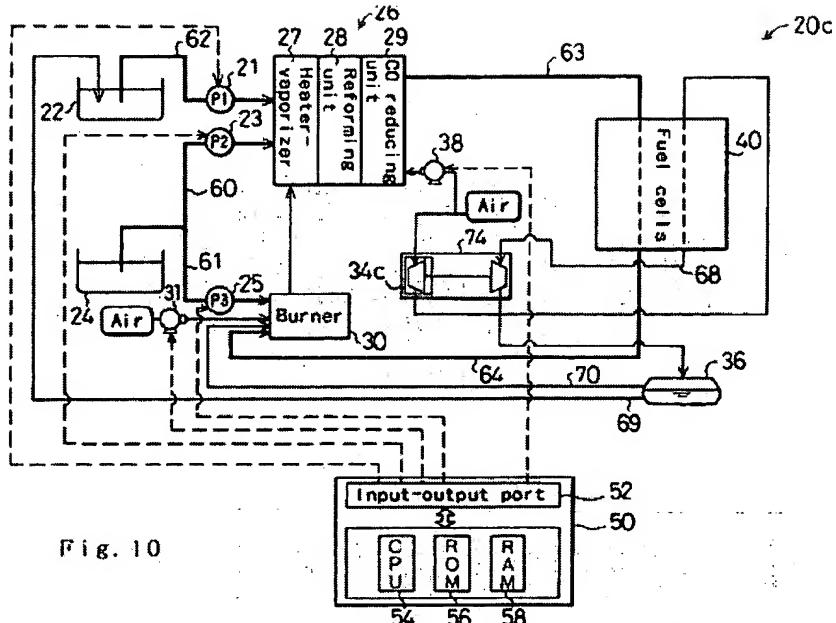


Fig. 10

With reference to the above figure, the system of Nitta includes a fuel cell 40 that is supplied with hydrogen gas 63 from a fuel processor 26. Atmospheric air is provided to compressor 74 which contains a magnetic oxygen enrichment unit 34c. Oxygen-enriched air is provided to the cathode region of the fuel cell, and the flowthrough is released as an exhaust oxidant gas 68. Notably, each embodiment disclosed in Nitta requires that the element corresponding to 34c be a magnetic oxygen enrichment assembly.

Nitta not only fails to disclose the system recited in amended claim 1, but also teaches away from the recited structure. First, as noted above, Nitta specifically requires the use of magnetic separation as the mechanism by which the oxygen-enriched stream is formed. Accordingly, it follows that Nitta fails to disclose the membrane-based oxygen-enrichment assembly recited in amended claim 1. Second, Nitta teaches away from the use of an oxygen-selective membrane to form its enriched-oxygen stream because Nitta

specifically discusses and rejects this type of oxygen-enrichment assembly. See, for example, column 2, lines 8-38 of Nitta. This specific discussion of why oxygen-enrichment assemblies that utilize oxygen-selective membranes are not viable for use in the system of Nitta therefore provides an express contradiction to the proposed modification of the system of Nitta to include such a membrane-based oxygen-enrichment assembly. Therefore, Applicants submit that Nitta also fails to render the subject matter of amended claim 1 obvious.

Finally, Applicants note that Nitta discusses in its background the fact the oxygen-selective membranes have been used for preparing oxygen-enriched streams. However, this discussion not only rejects the use of such membranes for fuel cell systems such as the system recited in amended claim 1, but also fails to disclose the use of oxygen-selective membranes in such systems. Specifically, the reference in Nitta (JP03-293092 to Sugiyama, Pressure Type Fuel Cell Power Generating System) discloses only the use of a membrane for separating air into oxygen-enriched and oxygen-depleted fractions, but fails to disclose or suggest the use of such a system in a fuel cell system, much less the system recited in amended independent claim 1.

For at least the above reasons, Applicants submit that amended claim 1 recites subject matter that is not disclosed or suggested in the cited references. As such, and upon consideration of amended claim 1, Applicants request that the rejections of original claim 1 be withdrawn and that amended claim 1 be allowed.

Claims 2-3, 6-10, 13, 16, 19-20, and 44-46 depend from amended claim 1 and therefore should be allowed when amended claim 1 is allowed. For the purpose of brevity, each of these dependent claims is not separately discussed in detail, and each

additional reason why these claims are believed to patentably distinguish the cited references is not presented. However, Applicants want to briefly discuss a few of these dependent claims and to present illustrative additional reasons why the claims should be allowed.

Claim 19 depends from claim 1 and recites that the water-recovery assembly is adapted to deliver the product water stream to a potable water supply. Nitta does not disclose or suggest providing the product water stream to a potable water supply. Instead, the entirety of the recovered water stream appears to be consumed as a reactant for the fuel processor of Nitta. In the Office action, claim 19 is rejected as being obvious over Nitta in view of Okamoto and Appleby on the grounds that it would have been obvious to recover the water from Nitta as a drinking water supply. However, Applicants respectfully submit that Nitta discloses a system wherein the entirety of the recovered water is supplied to the fuel processor. See elements 69 and 22 in the above-referenced figure of Nitta. As such, Nitta does not teach using this water as a potable water supply. Furthermore, there is no basis for modifying Nitta to provide the subject matter of claim 19, as doing so would reduce or eliminate a required feed stream for Nitta's fuel processor. As such, the proposed modification of Nitta would apparently destroy some of the recited functionality of Nitta's system. For at least this additional reason, Applicants submit that claim 19 should be allowed.

Claim 44, which is a new claim, depends from claim 1 and is supported in the specification at page 16, lines 14-20. Claim 44 recites that the oxygen-enrichment assembly is adapted to at least selectively reduce the concentration of air pollutants from the air stream. Nitta does not disclose or suggest an oxygen-enrichment assembly that is

adapted to selectively reduce the concentration of air pollutants from the air stream. The magnetic oxygen-enrichment assembly of Nitta raises the oxygen content of the air stream on the basis of oxygen's magnetic susceptibility, and nitrogen's lack of same. The assembly of Nitta, then, is likely to co-purify, with the oxygen, any air pollutants that have magnetic susceptibility. Co-purifying and concentrating such particles in the magnetic oxygen-enrichment assembly could lead to degraded performance of, and damage to, the fuel cell stack. For at least these additional reasons, Applicants submit that claim 44 should be allowed.

Claims 45 and 46, which are new claims, depend from claim 1 and are supported in the specification at page 14, lines 16-21. Claim 45 recites that the oxygen-enrichment assembly is adapted to produce a byproduct stream with a lower concentration of oxygen gas than the air stream, and that the byproduct stream is used to pressurize a supply of liquid fuel. Claim 46 recites that the pressurized supply of liquid fuel includes at least one carbon-containing feedstock and that this fuel is included in the feed stream to the fuel processor. Nitta does not disclose or suggest a fuel cell system wherein the byproduct stream is used to pressurize a supply of liquid fuel. In fact, Nitta does not teach or suggest specific uses for byproduct air, stating only that it is "discharged" (Nitta col. 13, line 65 to col. 14, line 5). The figures of Nitta similarly provide no further information on other uses for the discharged byproduct air. Therefore, Nitta does not disclose any use of the byproduct air discharged from the oxygen-enrichment assembly, much less the use of such a stream to pressurize a supply of liquid fuel, or even a supply of a feed stream for the fuel processor. For at least these reasons, Applicants submit that claims 45 and 46 should be allowed.

Amended independent claim 27 is similar to amended independent claim 1 in that both claims recite fuel cell systems that include an oxygen-enrichment assembly that utilizes at least one oxygen-selective membrane to produce an enriched oxygen stream that is delivered to the cathode region of the fuel cell stack and a water recovery assembly that is adapted to recover water from the cathode exhaust stream. Unlike claim 1, however, claim 27 is a method claim that recites a method for operating a fuel cell system. Amended independent claim 27 is reproduced below for the Examiner's convenience.

27. A method for operating a fuel cell system, the method comprising:

receiving an air stream having a concentration of oxygen gas;

producing from the air stream an oxygen-enriched stream containing a higher concentration of oxygen gas than the concentration of oxygen gas in the air stream, wherein the producing step occurs in at least one oxygen-selective membrane assembly adapted to receive the air stream and to produce therefrom the oxygen-enriched stream and a byproduct stream having a lower concentration of oxygen gas than the concentration of oxygen gas in the air stream;

delivering the oxygen-enriched stream to a cathode region of a fuel cell stack adapted to produce an electric current and water from the oxygen-enriched stream and a fuel stream, wherein the fuel cell stack is adapted to exhaust at least a cathode exhaust stream containing water;

recovering water from the cathode exhaust stream; and

utilizing at least a portion of the recovered water to produce additional fuel for the fuel stream.

More specifically, amended independent claim 27 recites, amongst other subject matter, producing via an oxygen-enrichment assembly that includes at least one oxygen-selective membrane an oxygen-enriched stream and a byproduct stream, delivering the oxygen-enriched stream to a cathode region of a fuel cell stack adapted to produce an electric current and a cathode exhaust stream containing water, recovering water from the cathode exhaust stream, and utilizing at least a portion of the recovered water to produce

additional fuel for a fuel stream. The arguments in favor of the patentability of independent claim 27 track closely with the arguments in favor of the patentability of claim 1 and, as such, will not be repeated verbatim here. Perhaps more specifically, because Nitta and the other cited references fail to disclose or suggest the system recited in amended independent claim 1, it follows that the references cannot disclose or suggest the method of operating the system recited in amended independent claim 27. As a more specific example, Nitta not only fails to disclose but also specifically disclaims and teaches away from the producing step recited in amended independent claim 27. As also discussed above, the background references also fail to disclose or suggest methods for using membrane-based oxygen enrichment assemblies in fuel cell systems, much less in systems in which water produced in the fuel cell stack is recovered and utilized to produce additional fuel for the fuel cell stack.

For at least the above reasons, Applicants submit that the method recited in amended independent claim 27 patentably distinguishes Nitta and the other cited references. As such, and upon consideration of amended claim 27, Applicants request that the rejections of claim 27 be withdrawn and that amended claim 27 be allowed.

Claims 28-29, 31, 33-36, and 47-49 depend from amended independent claim 27 and therefore should be allowed when amended independent claim 27 is allowed. For the purpose of brevity, each of these amended dependent claims is not discussed in detail and each additional reason why these claims are believed to patentably distinguish the cited references is not presented. However, Applicants want to briefly discuss a few of these dependent claims and to present illustrative additional reasons why the claims should be allowed.

Claim 47, which is a new claim, depends from claim 27 and is the analog to claim 44, which was discussed above. The method of claim 47 is supported in the specification at page 16, lines 14-20. Claim 47 recites that the oxygen-enrichment assembly is adapted to at least selectively reduce the concentration of air pollutants from the air stream. As noted above, Nitta does not disclose or suggest an oxygen-enrichment assembly adapted to selectively reduce the concentration of air pollutants from the air stream. In addition, the assembly of Nitta is likely to co-purify, with the oxygen, any air pollutants that have magnetic susceptibility. For at least these reasons, Applicants submit that new claim 47 should be allowed.

Claims 48 and 49, which are new claims, depend ultimately from claim 27 and are supported in the specification at page 14, lines 16-21. Claim 48 recites that the method includes a step of pressurizing a supply of liquid fuel with a byproduct stream. Claim 49 recites that the at least one carbon-containing feedstock in the utilization step includes a fuel from the pressurized supply of liquid fuel. As noted above, in the discussion of claims 45 and 46, Nitta does not disclose or suggest a fuel cell system wherein the byproduct stream is used to pressurize any supply of liquid fuel, much less a supply of the carbon-containing feedstock recited in claim 49. Nitta teaches and suggests only that the byproduct stream is “discharged” (Nitta col. 13, line 65-col. 14, line 5). Therefore, Nitta does not disclose any use of the byproduct air discharged from the oxygen-enrichment assembly. For at least these additional reasons, Applicants submit that claims 48 and 49 should be allowed.

New independent claim 50 is reproduced below for the Examiner's convenience.

50. A fuel cell system, comprising:

a fuel processing assembly adapted to produce a product hydrogen stream containing at least substantially pure hydrogen gas from at least one feed stream comprising at least a carbon-containing feedstock;

an air delivery system adapted to receive an air stream having a concentration of oxygen gas and to produce therefrom an oxygen-enriched stream having a greater concentration of oxygen gas than the air stream, wherein the air delivery system includes at least one oxygen-enrichment assembly adapted to produce the oxygen-enriched stream from the air stream;

a fuel cell stack adapted to receive at least a portion of the product hydrogen stream, the oxygen-enriched stream and a secondary air stream and to produce an electric current therefrom, wherein the fuel cell stack is adapted to emit a cathode exhaust stream containing water,

a water-recovery assembly adapted to receive the cathode exhaust stream and to produce a product water stream therefrom.

New claim 50 recites, amongst other subject matter, a fuel cell system with an air delivery system that includes an oxygen-enrichment assembly that is adapted to produce an oxygen-enriched stream from an air stream, and a fuel cell stack that is adapted to receive at least a portion of the product hydrogen stream from a fuel processing assembly, the oxygen-enriched stream, and a secondary air stream and to produce an electric current therefrom. Support for the elements recited in this claim can be found throughout the specification, and especially at page 17, lines 10-22. The claimed subject matter may also be found in Applicants' Figures 3-5.

The cited references do not disclose or teach the claimed subject matter. As noted above, Nitta discloses a number of configurations of a fuel cell system. However, in each of the configurations, the sole air stream for the fuel cell stacks comes from the magnetic separation devices. Accordingly, it follows that Nitta fails to disclose or suggest diluting the oxygen concentration, and potentially the pressure, of the oxygen-enriched stream

produced by the magnetic separation device to which the disclosure of Nitta is specifically directed. Therefore, Applicants submit that new independent claim 50 recites subject matter that is neither disclosed nor suggested in Nitta or the other references of record.

New claims 51-60 depend from new independent claim 50 and therefore should be allowed when claim 50 is allowed. For the purpose of brevity, Applicants want to briefly discuss a few of these dependent claims and to present illustrative reasons why the claims should be allowed.

New claims 52 and 53 recite that the oxygen-enriched and secondary air streams are received by the fuel cell stack as a mixed air stream and as separate air streams, respectively. Because Nitta does not disclose using a secondary air stream, it follows that Nitta does not disclose or suggest these configurations of a secondary air stream supply. For at least this additional reason, as well as those presented above regarding the subject matter of claim 50, Applicants submit that claims 52 and 53 should be allowed.

Claim 54 recites that the oxygen-enrichment assembly of the fuel cell system of claim 50 includes at least one oxygen-selective membrane. As noted above in the discussion of the subject matter of claim 1, Nitta disclaims the use of an oxygen-selective membrane assembly and instead describes in detail the utilization of a magnetic oxygen-enrichment assembly. For at least these reasons, and the reasons regarding the subject matter of claim 50, Applicants submit that claim 54 should be allowed.

New claim 59 recites that the fuel cell system includes a water-recovery assembly that is adapted to deliver the product water stream to a potable water supply, and new claim 60 recites that the oxygen-enrichment assembly is adapted to at least selectively

reduce the concentration of air pollutants from the air stream. New claims 59 and 60 should be allowed for the additional reasons presented above with respect to new claims 47 and 45, respectively.

New independent claim 61 is reproduced below for the Examiner's convenience.

61. A fuel cell system, comprising:

a fuel processing assembly adapted to produce a product hydrogen stream containing at least substantially pure hydrogen gas from at least one feed stream, wherein the at least one feed stream includes a carbon-containing feedstock from a supply of liquid fuel;

an air delivery system adapted to receive an air stream having a concentration of oxygen gas and to produce therefrom an oxygen-enriched stream having a greater concentration of oxygen gas than the air stream and a byproduct stream having a lower concentration of oxygen gas than the air stream, wherein the air delivery system includes at least one oxygen-enrichment assembly adapted to produce the oxygen-enriched stream from the air stream, and further wherein the byproduct stream is used to pressurize the supply of liquid fuel;

a fuel cell stack adapted to receive at least a portion of the product hydrogen stream and the oxygen-enriched stream and to produce an electric current therefrom; wherein the fuel cell stack is adapted to emit a cathode exhaust stream containing water; and

a water-recovery assembly adapted to receive the cathode exhaust stream and to produce a product water stream therefrom.

New claim 61 recites, amongst other subject matter, a fuel cell system with a fuel processing assembly that is adapted to produce a product hydrogen stream, an air delivery system that is adapted to receive an air stream and to produce an oxygen-enriched stream and a byproduct stream therefrom, and a fuel cell stack that is adapted to receive at least a portion of the product hydrogen stream and the oxygen-enriched stream and to produce an electric current therefrom. New claim 61 further recites that the byproduct stream is used to pressurize a supply of liquid fuel. As noted above with respect to claims 48 and 49, support for the claimed subject matter can be found in Applicants' specification at page 14, lines 16-21. As discussed above, Nitta does not disclose or suggest a fuel cell

system in which the byproduct stream is used to pressurize a supply of liquid fuel. Instead, Nitta teaches and suggests only that the byproduct stream is “discharged” (Nitta col. 13, line 65-col. 14, line 5). For at least this reason, Applicants submit that claim 61 should be allowed.

Claims 62-68 depend from new independent claim 61 and therefore should be allowed when new independent claim 61 is allowed.

Claim 62 recites that the oxygen-enrichment assembly of claim 61 includes at least one oxygen-selective membrane. As noted above in the discussion of amended claim 1, Nitta does not teach or disclose the use of an oxygen-selective membrane in the claimed fuel cell system. Nitta expressly disclaims the use of membrane-based systems, refers to an incompatible membrane system in its background discussion, and focuses exclusively on magnetic oxygen separation. For at least these reasons, discussed in detail above, Applicants submit that claim 62 should be allowed.

Claim 67 recites that the fuel cell system of claim 61 is adapted to deliver the product water stream to a potable water supply. As noted above in the discussion of claim 19, Applicants respectfully submit that Nitta discloses a system where the entirety of the recovered water is supplied to the fuel processor. As such, Nitta does not teach using this recovered water as a potable water supply. For at least this reason, Applicants submit that claim 68 should be allowed.

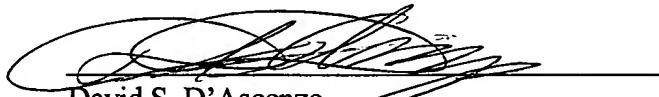
Claim 68 recites that the oxygen-enrichment assembly is adapted to at least selectively reduce the concentration of air pollutants from the air stream. As noted above in the discussion of claim 44, the magnetic enrichment assembly of Nitta raises the oxygen content of the air stream on the basis of oxygen’s magnetic susceptibility, and

nitrogen's lack of same. The assembly of Nitta, then, is likely to co-purify, with the oxygen, any air pollutants that have magnetic susceptibility. For at least this reason, Applicants submit that claim 68 should be allowed.

With the entry of the above amendments, and for the reasons discussed herein, Applicants submit that all of the issues raised in the first Office action have been addressed and overcome. If there are any remaining issues or if the Examiner has any questions, Applicants' undersigned attorney may be reached at the number listed below. Similarly, if the Examiner believes that a telephone interview may be productive in advancing prosecution of the present application, the Examiner is invited to contact Applicants' undersigned attorney at the number listed below.

Respectfully submitted,

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